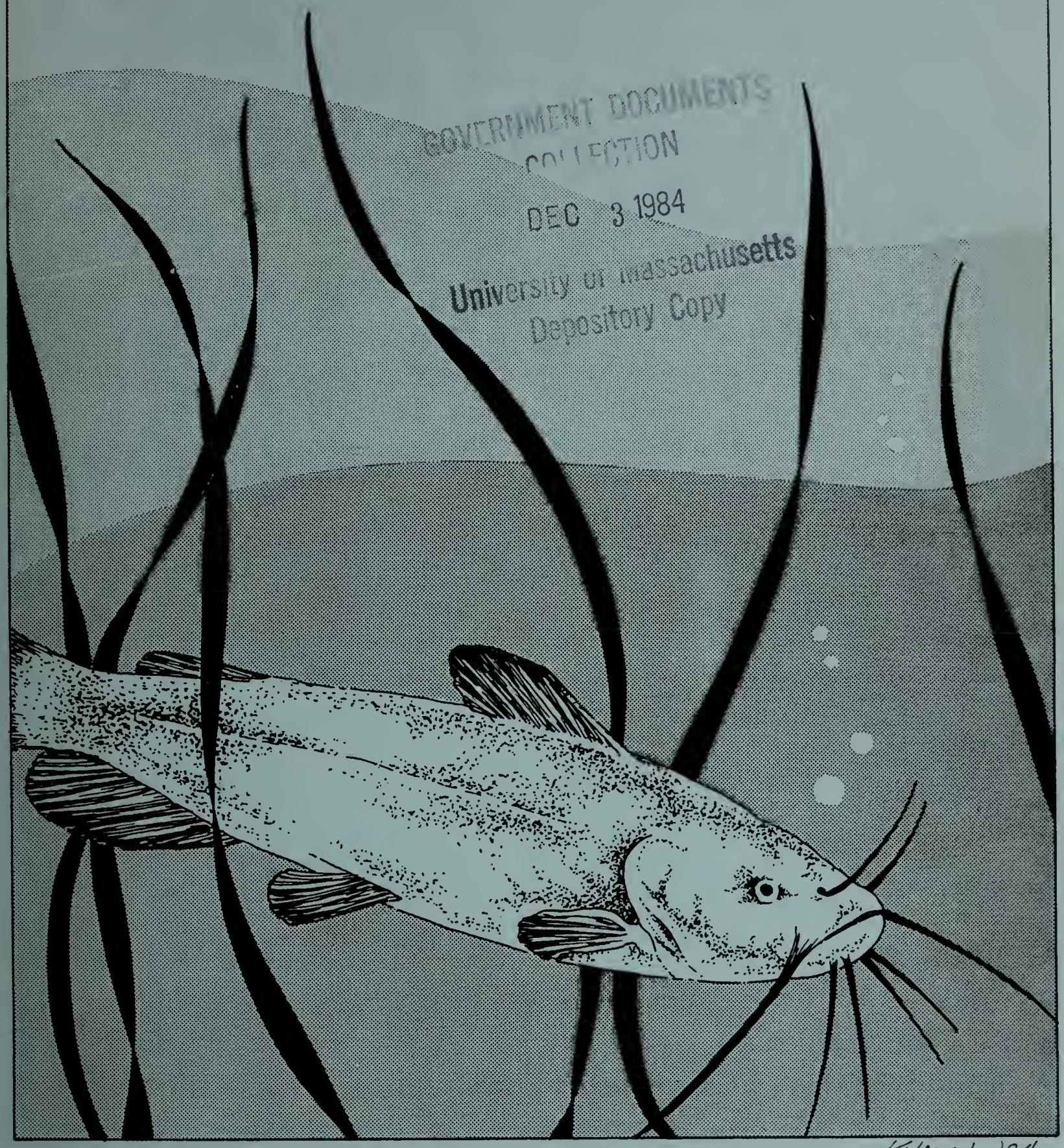
SIX PONDS DIOXIN SURVEY



KALAMON '84

Massachusetts Department of Environmental Quality Engineering

DIVISION of WATER POLLUTION CONTROL

Thomas C. McMahon, Director

SIX PONDS DIOXIN SURVEY

1983

Prepared by

Technical Services Branch

Division of Water Pollution Control

Massachusetts Department of Environmental Quality Engineering

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INTRODUCTION

Recently, concern has been expressed over the environmental impact and human health effects of 2,3,7,8-Tetrachlorodibenzo-p-dioxin or more simply, dioxin. In Massachusetts, dioxin may be found in places where certain herbicides have been used. In particular, a number of our lakes and ponds have been treated with the herbicides called Silvex, Kuron or 2,4,5-T. Dioxin is an accidental contaminant found in these chemicals, formed during the manufacturing process.

During 1983, the Department of Environmental Quality Engineering, Division of Water Pollution Control, conducted a screening survey of six ponds with histories of treatment with Silvex, Kuron or 2,4,5-T. The Division of Fisheries and Wildlife cooperated in this survey by providing both personnel and equipment for the field work. The survey objective was to determine if 2,3,7,8-Tetrachlorodibenzo-p-dioxin is presently a real concern even though use of the listed herbicides was halted in 1978.

This report describes the work done and the results of the sample analyses. All field work was performed by the professional staffs of the Division of Water Pollution Control and the Division of Fisheries and Wildlife. Laboratory analysis, including sample preparation was performed by Battelle New England Marine Research Laboratory in Duxbury and Battelle Columbus Laboratory, Columbus, Ohio, under contract with the Division of Water Pollution Control. Battelle was selected because of their ability to conduct the analysis in the range of concentrations needed (parts per trillion) and their acceptance by other professionals for performing quality work.

Description of the Study Area

Lake Winthrop (Fig. 1)

Town:	Holliston
County:	Middlesex
River Basin:	Charles
Surface Area:	41 hectares (102 acres)
Maximum Depth:	6.1 meters (20 feet)
Mean Depth:	3 meters (9.8 feet)
Water Uses:	Swimming, fishing, ice fishing, boating, ice skating
Herbicide Treatment History: (1) (2)	1958 Kuron 1959 Kuron 1969 Kuron 1970 Kuron 1971 Kuron

Boons Pond (Fig. 2)

Towns:	Hudson/Stow
County:	Middlesex
River Basin:	Assabet
Surface Area:	66 hectares (163 acres)
Maximum Depth:	Basin #1 = 6.1 meters (20 feet) Basin #2 & 3 = 3.1 meters (10 feet)
Mean Depth:	Basin #1 = 4.2 meters (13.8 feet) Basin #2 & 3 = 1.9 meters (6.3 feet)
Water Uses:	Swimming, fishing, ice fishing, boating, ice skating
Herbicide Treatment History:	1961 2,4,5-T 1961 Kuron 1965 Kuron 1965 Silvex

(1) Only herbicides of concern are listed

(2) Records of herbicide applications were lacking data or it was improperly recorded. Accurate estimates of quantities used, concentrations and exact locations were often not available in the records.

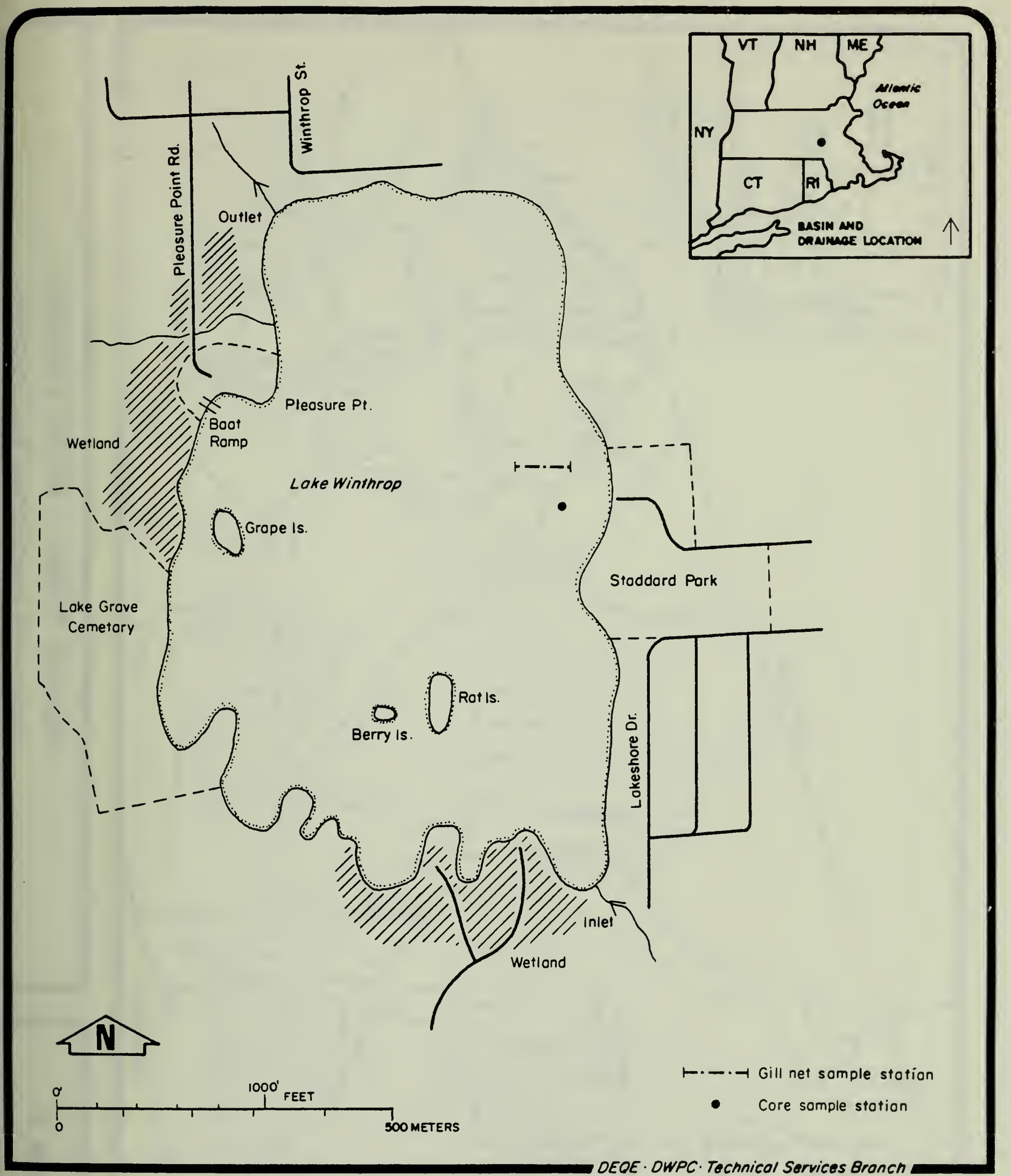

Figure 1

LAKE WINTHROP - HOLLISTON
Area-41 hectares(102 acres)

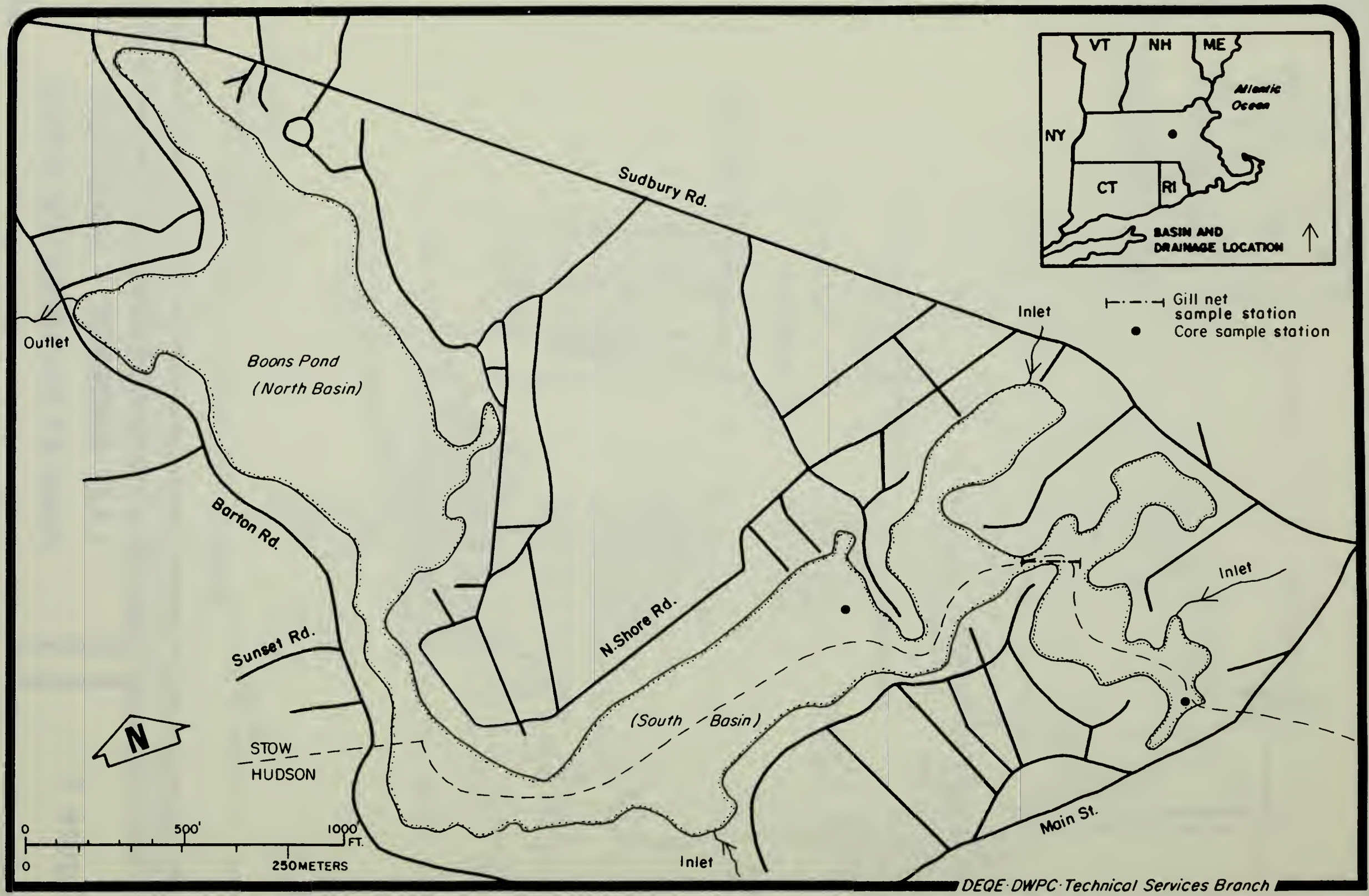

Figure 2

BOONS POND - STOW/HUDSON
Area-66 hectares(163 acres)

Flint Pond (Fig. 3)

Towns:	Shrewsbury/ Grafton/Worcester
County:	Worcester
River Basin:	Blackstone
Surface Area:	120 hectares (297 acres)
Maximum Depth:	4.6 meters (1.5 feet)
Mean Depth:	2.7 meters (8 feet)
Water Uses:	Swimming, fishing, ice fishing, boating, ice skating
Herbicide Treatment History:(1)	1958 Kuron 1961 Kuron 1962 Kuron 1963 Kuron

Nonesuch Pond (Fig. 4)

Towns:	Natick/Weston
County:	Middlesex
River Basin:	Charles
Surface Area:	14 hectares (35 acres)
Maximum Depth:	1.2 meters (4 feet)
Mean Depth:	1.2 meters (4 feet)
Water Uses:	Swimming, fishing, boating
Herbicide Treatment History:(1)	1961 Kuron

Stockbridge Bowl (Lake Mahkeenac) (Fig. 5)

Town:	Stockbridge
County:	Berkshire
River Basin:	Housatonic
Surface Area:	151 hectares (374 acres)
Maximum Depth:	14 meters (46 feet)
Mean Depth:	8.0 meters
Water Uses:	Swimming, fishing, ice fishing, boating, ice skating

(1) Only herbicides of concern are listed.

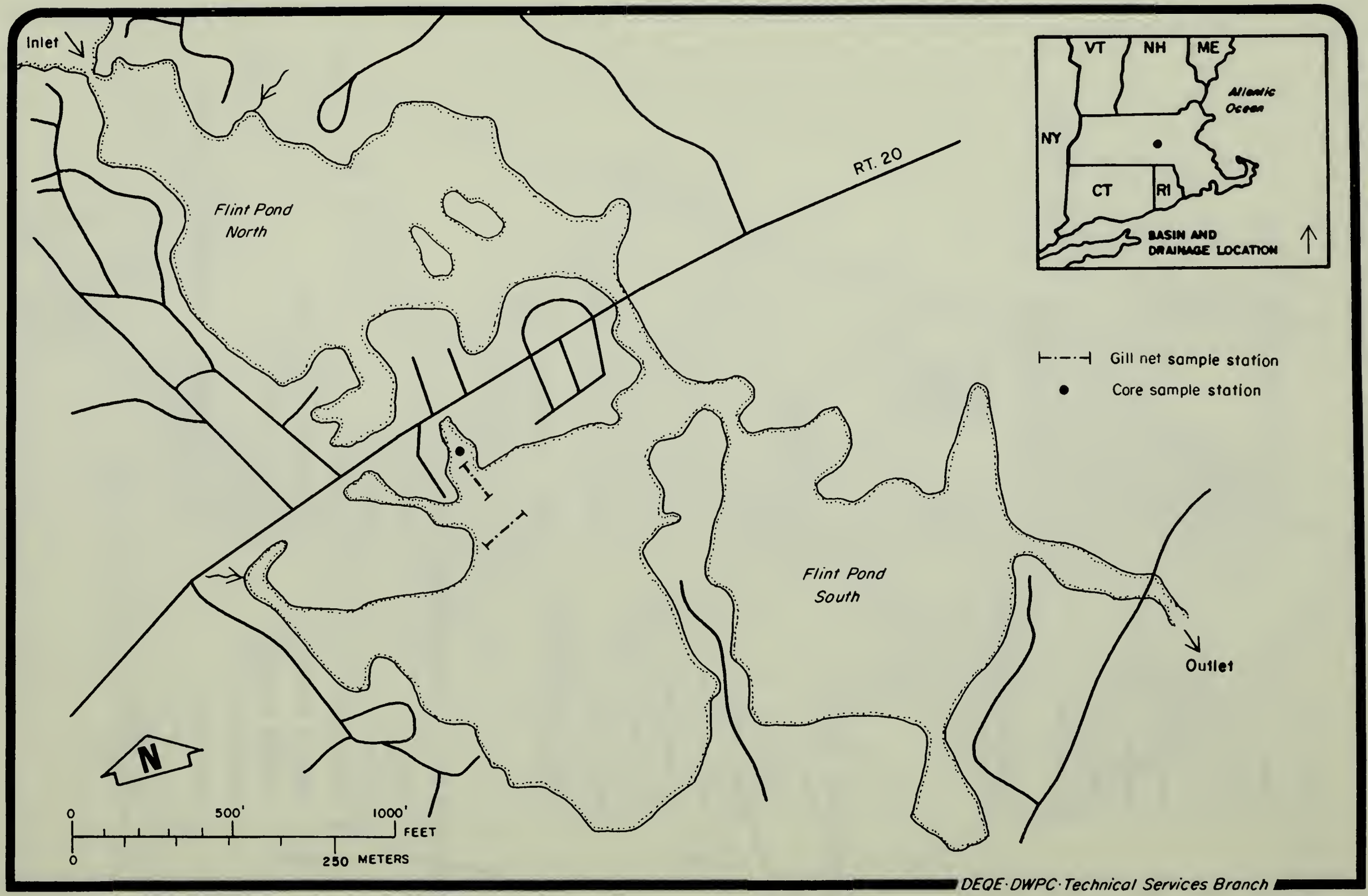

Figure 3

FLINT POND - WORCESTER/SHREWSBURY/GRAFTON
Area-120 hectares(297 acres)

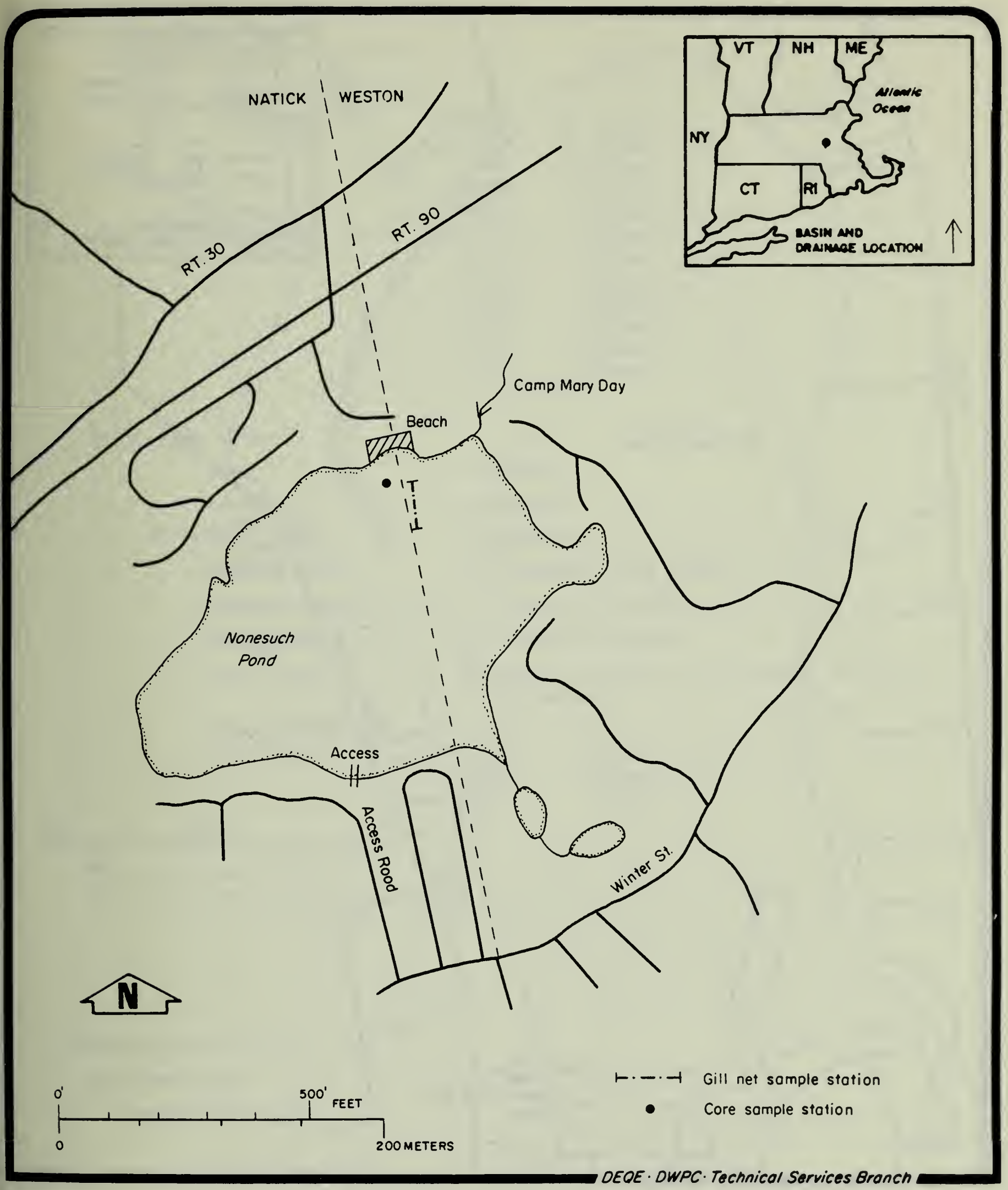

Figure 4

NONESUCH POND - NATICK/WESTON
Area- 14 hectares(35 acres)

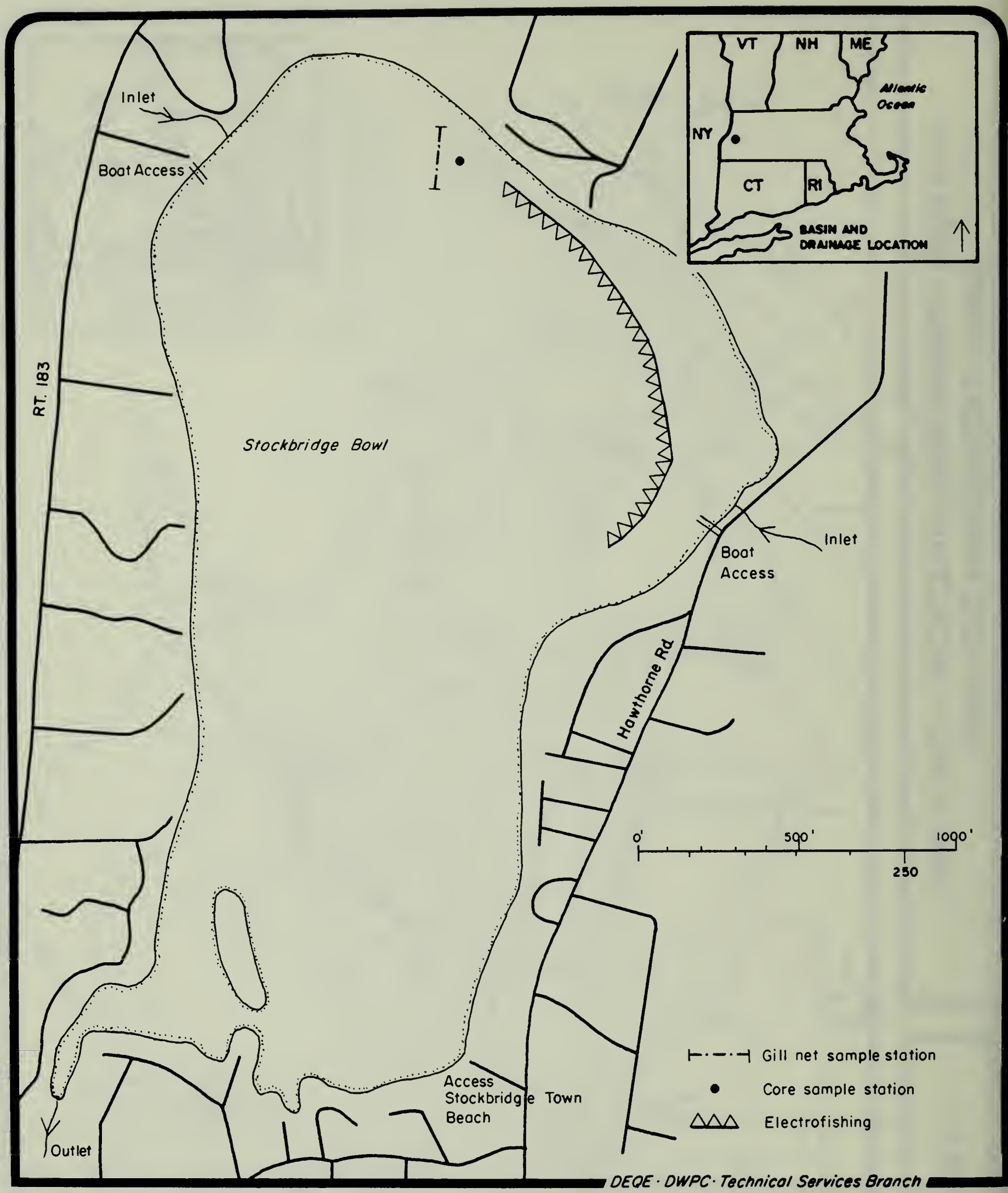

Figure 5

STOCKBRIDGE BOWL - STOCKBRIDGE
Area-151 hectares(374 acres)

Stockbridge Bowl (Continued)

Herbicide Treatment History:(1)

1960	Silvex
1961	Silvex
1966	Kuron
1968	Kuron
1969	Kuron
1972	Kuron
1974	Kuron
1976	Kuron
1976	Silvex
1977	Silvex
1978	Silvex
1978	Kuron

North Pond (Fig. 6)

Town:	Hopkinton
County:	Middlesex
River Basin:	Blackstone
Surface Area:	105 hectares (260 acres)
Maximum Depth:	6.1 meters (20 feet)
Mean Depth:	2.4 meters (8 feet)
Water Uses:	Swimming, fishing, ice fishing, boating, ice skating

Herbicide Treatment History:(1)

1967	Kuron
1974	Silvex
1976	Silvex

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(1) Only herbicides of concern are listed

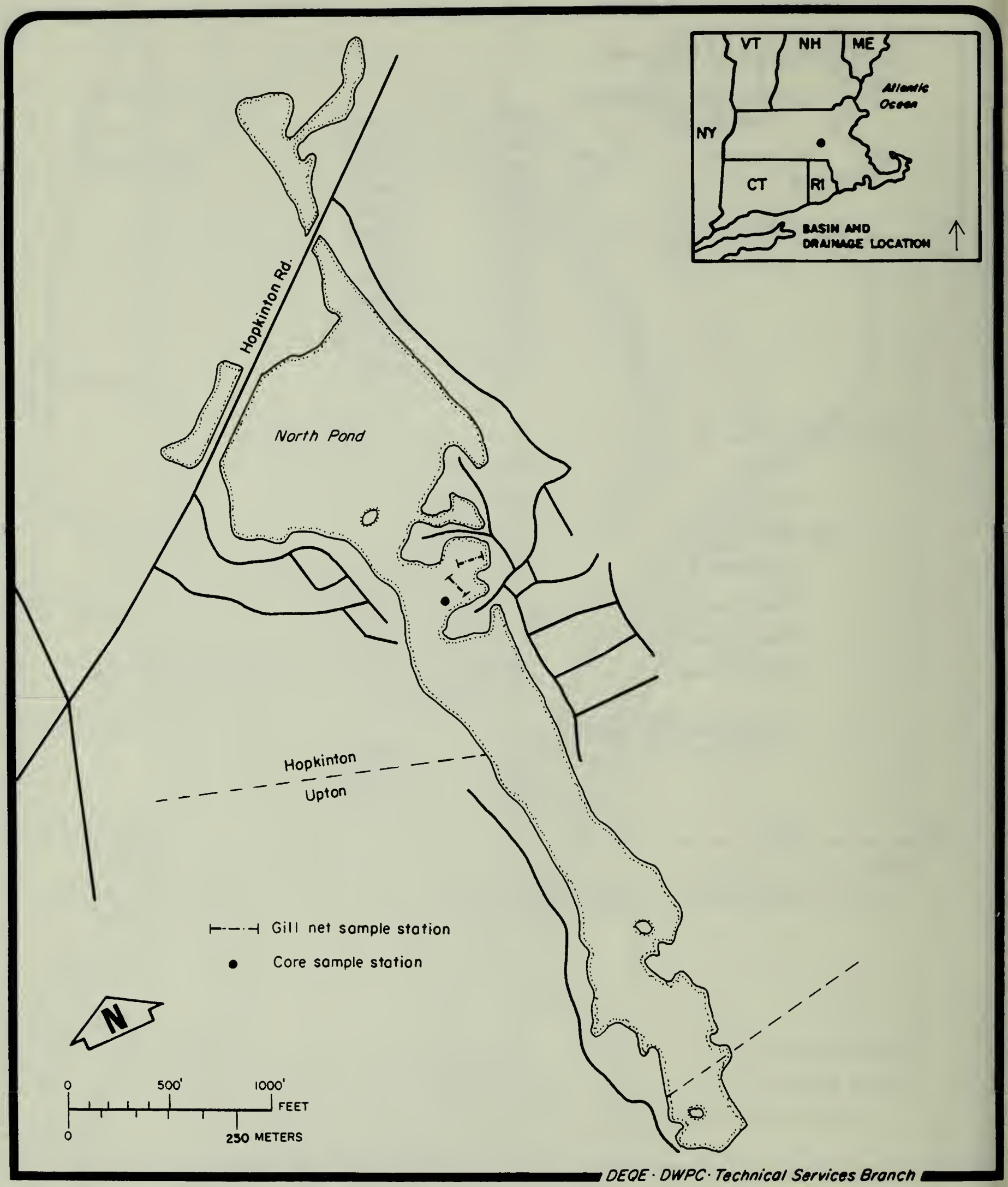

Figure 6

NORTH POND - HOPKINTON
Area-105 hectares(260 acres)

Sampling and Analytic Methodology

Sediment

Two vertical, cylindrical core samples of the bottom sediment were taken in each pond at sites known to have been treated with Silvex, Kuron or 2,4,5-T based on treatment records. A Wildco Corer, Model 2321 A10 was used to collect the samples. The 2"x24" liner, egg shell core catchers and tube end caps were brand new. No equipment which contacted the samples were used for more than one sample except the nose cone. Each core was stored in a separate teflon container and labeled. All samples were placed on dry ice immediately and transported directly to the Battelle New England Marine Research Laboratory (NEMRL) within 24 hours. There, the cores were composited into one sample for each pond.

Fish

Five bullhead (*Ictalurus* spp.) were captured by monofilament gill net or electrofishing within the area of each pond known to have been treated. The species collected (Table 1) are bottom dwelling, bottom feeding fish with relatively high body fat. It was believed that this combination of factors provided the best opportunity for finding dioxin in fish. Upon capture, each fish was weighed, measured, wrapped in solvent washed aluminum foil and placed in a tagged plastic bag. They were then placed on dry ice until turned over to NEMRL.

NEMRL biologists filleted each fish with the skin on. The left fillets of the five fish collected from each pond were composited into one sample. The right fillets were archived frozen for future reference. In addition, the left pectoral spine was excised for age analysis, and stomachs removed for food analysis.

Massachusetts Division of Fisheries and Wildlife biologists determined the age of each fish by sectioning the pectoral spine, mounting a 0.017" thick wafer and examining it under a binocular microscope with transmitted light. The zones of growth appeared as translucent rings alternating with opaque bands. Each ring was regarded as a year mark.

Massachusetts Division of Water Pollution Control biologists examined the contents of all stomachs using various taxonomic references.

Analysis for Dioxin

Upon completion of all collections, NEMRL shipped all samples to be analyzed to the Battelle Columbus Laboratory in Ohio. Samples were shipped in dry ice and sent blind with only laboratory code identifiers for each sample. This means that the Columbus Laboratory was unaware of which lake each sample came from or even which sediment and fish samples were from the same lake. Lake identifications were given to the samples only when results were reported back to NEMRL.

The Battelle Columbus Laboratory determined the presence and concentration of 2,3,7,8-Tetrachlorodibenzo-p-dioxin using combined capillary column gas chromatography/high resolution mass spectrometry. A discussion of the extraction, analytic and quantification procedures is contained in the Battelle report presented to the DEQE. This document is on file at the Technical Services Branch in Westborough (Boehm and Saksa, 1983).

RESULTS OF ANALYSIS

Five of the six sediment samples analyzed did not meet the analytic criteria for positive identification of dioxin. Detection limits ranged from 3.0 parts per trillion to 5.5 parts per trillion (Table 2). The sixth pond, Lake Winthrop did meet the criteria for positive identification and the sediment had a dioxin concentration of 5.9 parts per trillion.

Similarly, five of the six composited fish samples did not meet the criteria for positive identification of dioxin. Detection limits ranged from 1.3 parts per trillion to 7.5 parts per trillion. The sixth pond, again Lake Winthrop, did have a positive response to dioxin with a concentration of 71 parts per trillion.

All fish were at least two years old with the oldest being seven-plus. The plus is used to recognize the vagary of a hatching date. Since the bullheads were hatched in the late spring or early summer, they were all between four and six months past their last "birthday" when captured. The mean age of all fish, using year plus 6 months to calculate, was 5 years old.

Mean age for fish in all lakes samples varied from 3.7 years to 6.9 years with standard deviations ranging from 0.55 to 1.52 (Table 3). The Lake Winthrop fish were slightly younger than the group mean of 5 years.

Analysis of the stomach contents of all fish samples showed that fish predominate in the bullhead diet in Flint Pond, North Pond and Boons Pond (Tables 4,5 and 6). Invertebrates including pelecypods, gastropods and insect sub-adults were more abundant in the stomachs of bullheads from Nonesuch Pond, Lake Winthrop and Stockbridge Bowl (Tables 7,8, and 9). Due to the small number of fish sampled and the instantaneous nature of the sampling, few generalizations are possible. However, no unusual feeding patterns were indicated.

Table 1. Age, Length, Weight and Species of Fish Sampled from Six Massachusetts' Lakes. 1983

BOONS POND, HUDSON/STOW

	SPECIES	LENGTH (mm)	WEIGHT (gm)	AGE (yrs)	DATE CAPTURED
1.	Yellow Bullhead (Ictalurus natalis)	233	198	4+	9/7/83
2.	Brown Bullhead (Ictalurus nebulosus)	315	454	5+	9/8/83
3.	Yellow Bullhead (Ictalurus natalis)	260	283	6+	9/8/83
4.	Yellow Bullhead (Ictalurus natalis)	292	368	6+	9/8/83
5.	Yellow Bullhead (Ictalurus natalis)	270	368	6+	9/8/83

NONESUCH POND, NATICK

	SPECIES	LENGTH (mm)	WEIGHT (gm)	AGE (yrs)	DATE CAPTURED
1.	Brown Bullhead (Ictalurus nebulosus)	372	652	5+	9/7/83
2.	Brown Bullhead (Ictalurus nebulosus)	270	255	3+	9/7/83
3.	Brown Bullhead (Ictalurus nebulosus)	296	368	2+	9/7/83
4.	Brown Bullhead (Ictalurus nebulosus)	268	255	3+	9/7/83
5.	Yellow Bullhead (Ictalurus natalis)	255	283	5+	9/7/83

Table 1. (Continued)

STOCKBRIDGE BOWL, STOCKBRIDGE

	SPECIES	LENGTH (mm)	WEIGHT (gm)	AGE (yrs)	DATE CAPTURED
1.	Brown Bullhead (Ictalurus nebulosus)	240	170	5+	9/13/83
2.	Brown Bullhead (Ictalurus nebulosus)	211	113	2+	9/13/83
3.	Brown Bullhead (Ictalurus nebulosus)	208	99	3+	9/13/83
4.	Brown Bullhead (Ictalurus nebulosus)	217	135	2+	9/13/83
5.	Brown Bullhead (Ictalurus nebulosus)	231	156	4+	9/13/83

NORTH POND, HOPKINTON

	SPECIES	LENGTH (mm)	WEIGHT (gm)	AGE (yrs)	DATE CAPTURED
1.	White Catfish (Ictalurus catus)	305	397	7+	8/31/83
2.	White Catfish (Ictalurus catus)	170	255	5+	8/31/83
3.	White Catfish (Ictalurus catus)	305	368	5+	9/1/83
4.	White Catfish (Ictalurus catus)	302	397	5+	9/1/83
5.	Brown Bullhead (Ictalurus nebulosus)	260	227	5+	8/31/83

Table 1. (Continued)

LAKE WINTHROP, HOLLISTON

	SPECIES	LENGTH (mm)	WEIGHT (gm)	AGE (yrs)	DATE CAPTURED
1.	Brown Bullhead (*Ictalurus nebulosus*)	255	227	3+	9/1/83
2.	Brown Bullhead (*Ictalurus nebulosus*)	276	283	4+	9/1/83
3.	Brown Bullhead (*Ictalurus nebulosus*)	302	312	4+	9/2/83
4.	Yellow Bullhead (*Ictalurus natalis*)	300	454	4+	9/2/83
5.	Brown Bullhead (*Ictalurus nebulosus*)	275	283	3+	9/2/83

FLINT POND, SHREWSBURY/GRAFTON/WORCESTER

	SPECIES	LENGTH (mm)	WEIGHT (gm)	AGE (yrs)	DATE CAPTURED
1.	Yellow Bullhead (*Ictalurus natalis*)	320	595	6+	9/7/83
2.	Yellow Bullhead (*Ictalurus natalis*)	335	680	7+	9/7/83
3.	Yellow Bullhead (*Ictalurus natalis*)	235	397	6+	9/7/83
4.	Yellow Bullhead (*Ictalurus natalis*)	305	454	7+	9/7/83
5.	Yellow Bullhead (*Ictalurus natalis*)	335	595	6+	9/7/83

Table 2. 2,3,7,8-Tetrachlorodibenzo-p-dioxin Concentrations in Fish and Sediment Samples from Six Massachusetts' Lakes. 1983

Lake	Fish Sample (ppt)	Sediment Sample (ppt)
Lake Winthrop	71	5.9
Flint Pond	ND[3] (1.2)[1]	ND (5.5)
Boons Pond	ND (2.3)	ND (5.1)
Nonesuch Pond	ND (3.0)[2]	ND (3.6)[2]
Stockbridge Bowl	ND (7.5)	ND (3.2)[2]
North Pond	ND (3.5)	ND (3.0)

[1] Concentrations in parentheses are detection limits

[2] Showed response for dioxin but did not meet criteria for positive identification

[3] None detected

Table 3. Mean Ages of Fish Sampled from Six Massachusetts' Lakes

LAKE	MEAN AGE (years)	STANDARD DEVIATION
Stockbridge Bowl	3.7	1.30
Nonesuch Pond	4.1	2.52
Lake Winthrop	4.1	0.55
Boons Pond	5.9	0.89
North Pond	5.9	0.89
Flint Pond	6.9	0.55

Table 4. Food Analysis of Five Bullhead from Flint Pond, Shrewsbury/Grafton/Worcester

ITEM	NUMBER OF STOMACHS	NUMBER OF ITEMS
Bluegill	1	1
Unidentifiable fish	1	1
Fish scales	2	--[1]
Digested matter	3	--

[1]Not counted

Table 5. Food Analysis of Five Bullhead from North Pond, Hopkinton

ITEM	NUMBER OF STOMACHS	NUMBER OF ITEMS
Crayfish claw	1	1
Digested matter	1	--[1]
Filamentous algae	3	--
Fibrous plant material	2	--
Empty	1	

[1]Not counted

Table 6. Food Analysis of Five Bullhead from Boons Pond, Hudson/ Stow

ITEM	NUMBER OF STOMACHS	NUMBER OF ITEMS
Fish scales	2	--[1]
Fish bones	3	--
Fish spine	1	1
Fibrous plant material	2	--
Digested matter	3	--
Unidentifiable fish	1	1
Filamentous algae	1	--
Empty	1	--

[1]Not counted

Table 7. Food Analysis of Five Bullhead from Nonesuch Pond, Natick

ITEM	NUMBER OF STOMACHS	NUMBER OF ITEMS
Midge fly larva (Tendipedidae)	3	15
Dragonfly nymph (Anisoptera)	1	1
Caddisfly larva (Leptoceridae)	1	1
Caddisfly larva (Hydroptilidae)	3	8
Snails (Gastropoda)	1	29
Clams & mussels (Pelecypoda)	2	8
Filamentous algae	3	--[1]
Unidentifiable caddisfly	1	1
Fibrous plant material	3	--
Unidentified worms	1	2
Plant seeds	2	24
Fish scales	1	3
Digested matter	3	--
Empty	1	--

[1]Not counted

Table 8. Food Analysis of Five Bullhead from Lake Winthrop, Holliston

ITEM	NUMBER OF STOMACHS	NUMBER OF ITEMS
Biting midge fly larva (Ceratopogonidae)	1	19
Midge fly larva (Tendipedidae)	3	97
Caddisfly larva (Trichoptera)	1	94
Caddisfly case (Trichoptera)	1	1
Clams & mussels (Pelecypoda)	2	21
Snails (Gastropoda)	2	29
Aquatic earthworm (Oligochaeta)	1	3
Fish bones (yellow perch)	1	--
Fish scales (yellow perch)	1	--
Other fish scale	1	1
Fibrous plant material	2	--
Digested matter	2	--
Detritus	1	--
Empty	1	--

Table 9. Food Analysis of Five Bullhead from Stockbridge Bowl, Stockbridge

ITEM	NUMBER OF STOMACHS	NUMBER OF ITEMS
Snails (Gastropoda)	4	24
Caddisfly larva (Trichoptera)	2	9
Biting midge fly larva (Ceratopogonidae)	1	1
Midge fly larva (Tendipedidae)	1	1
Aquatic earthworms (Oligochaeta)	1	30-70
Clams & mussels (Pelecypoda)	2	10
Fibrous plant material	4	--[1]
Mineral	1	--
Plant seeds	3	32
Digested matter	4	--
Pebble	1	1
Filamentous algae	1	--

[1]Not counted

CONCLUSIONS AND DISCUSSION

1. The food habits analysis suggest that the fish comprising the six samples are typical in their habits and that the fish are comparable between lakes in this study.

2. The age analysis shows that all fish have had at least 2.5 years of exposure in their respective lakes with a study wide average of 4.9 years.

3. The finding of 5.9 ppt dioxin in the sediment and 71 ppt dioxin in the fish of Lake Winthrop is positive confirmation of the presence of dioxin.

4. The presence of dioxin in Lake Winthrop is of concern for two reasons:

   a. The 71 ppt found in fish exceeds the U.S. Food and Drug Administration guideline of 50 ppt in fish flesh for human consumption. Therefore, the situation may represent a public health concern.

   b. Lake Winthrop appears to have been treated very little over the years compared to the other lakes studied. Therefore, no explanation is apparent for the finding of dioxin in this lake and not the others.

5. If we assume that the mean age of the Lake Winthrop fish represents an adequate time period of exposure for bullhead to accumulate dioxin, five of the six fish samples meet the time criteria for dioxin accumulation. Stockbridge Bowl fish are the only sample which might not have had adequate exposure time.

RECOMMENDATIONS

1. Analyze the five archived fish from Lake Winthrop to confirm the original results. Analyze them individually to obtain a range of concentrations within the sample fish.

2. Collect more bullheads from Lake Winthrop at several locations to confirm the original results and obtain a broader base for range of concentration.

3. Collect other species of fish used as food by humans to assess the human health threat and study transport through the food chain since humans consume many predators.

4. Department of Environmental Quality Engineering, the Department of Public Health and the U.S. Environmental Protection Agency should determine if a human health threat exists, its extent, and what protective measures are necessary.

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APPENDIX A.

Phase II Dioxin Survey - Lake Winthrop, Holliston

Introduction

The results of the initial dioxin screening survey were cause for concern because they were not anticipated. Lake Winthrop has a herbicide treatment history involving few documented applications. Therefore, Lake Winthrop had some of the lightest herbicide applications of all the ponds tested. Yet, the tests showed that the sediment sample contained 5.9 ppt. (parts per trillion) dioxin and the bullheads contained 71 ppt. dioxin.

After a technical review of the Battelle report by Technical Services Branch personnel and Lawrence Experiment Station personnel, a series of meetings were held to analyze the data and plan a course of action. Representatives from the senior DEQE staff, Department of Public Health, Lawrence Experiment Station, Division of Water Pollution Control's Technical Services Branch, and the U.S. Environmental Protection Agency were involved in the meetings.

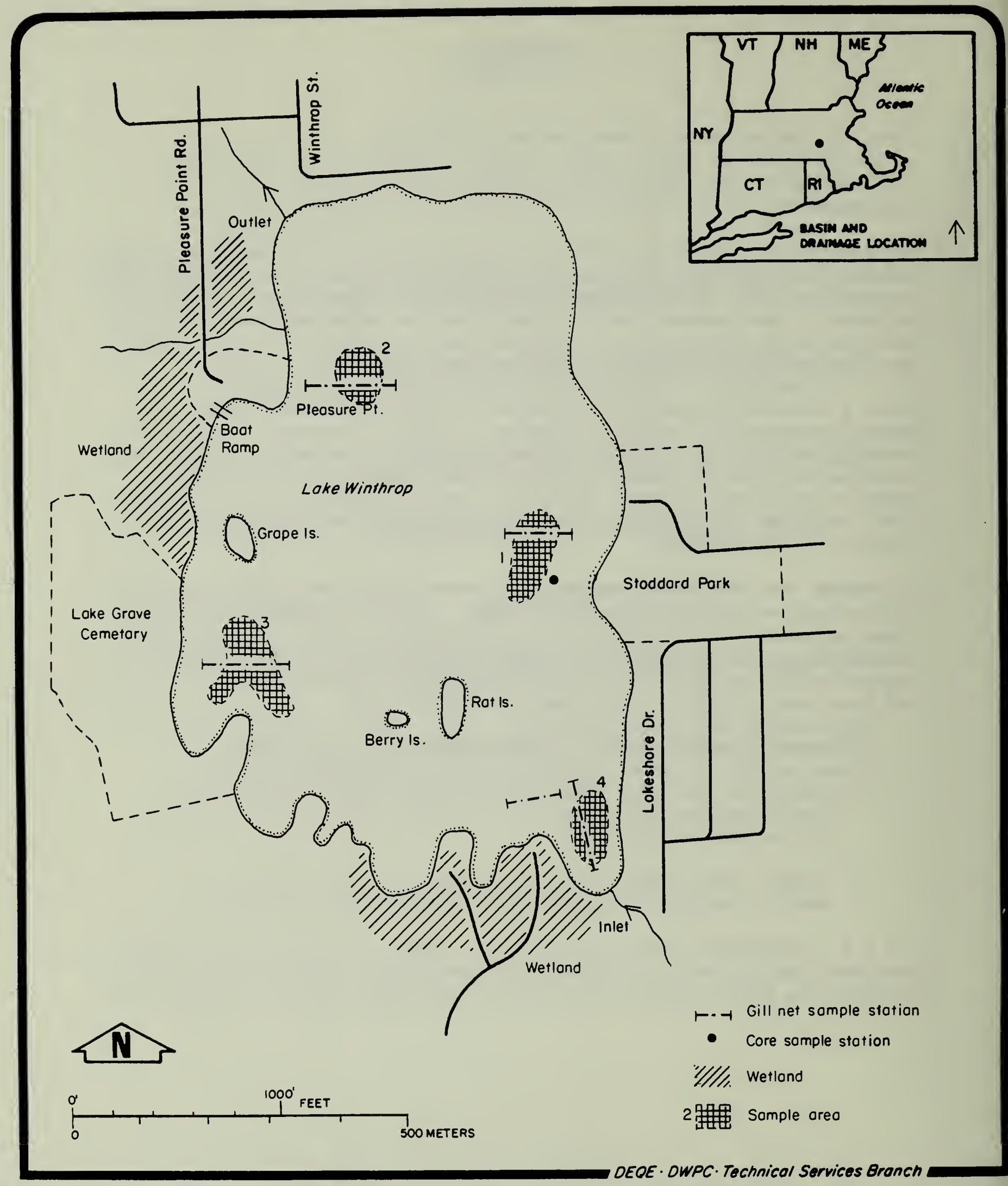
A decision was made that confirmation of the initial results was essential before any other actions were taken. A plan was formulated to include retesting of the five archived bullheads from Lake Winthrop individually in order to confirm the initial results and to learn what the concentrations were in each fish. In addition, more fish would be collected from Lake Winthrop. The sample objectives were:

1. Resample at the original sample site (Fig. A1, station #1)

2. Sample at shoreline areas near Pleasure Point (station #2), Lake Grove Cemetary (station #3), and the cove where an inlet is located (station #4).

3. Collect five bullhead from each station plus five yellow perch, five chain pickerel and five bass from station #1.

The U.S. Environmental Protection Agency agreed to provide laboratory support and funding for the analysis of these samples. Accordingly, they selected the Brehm Laboratory at Wright State University in Dayton, Ohio.



DEQE · DWPC · Technical Services Branch

Figure A-1

LAKE WINTHROP – HOLLISTON
SAMPLE STATION LOCATION

Methods

On December 6, 1983, Division of Water Pollution Control biologists set four monofilament gill nets. One net was located at each sample station as planned. In order to set these nets, it was necessary to break 1/2" of ice cover on the lake. Nets were checked daily until December 9 when they were removed and sampling ended due to adverse weather. On the 7th, 40-50 mph winds made work difficult and on the 8th and 9th, ice formed, eventually reaching a thickness of one inch.

Fish collections did not fulfill the objectives. No bullhead were captured, no bass were captured and only two yellow perch were captured but three samples of 5 chain pickerel were taken (Table A1).

Fish handling procedures were identical to Phase I except that the fish were taken to the DEQE Lawrence Experiment Station for storage and processing. A DWPC biologist prepared all samples for shipping by filleting and skinning the fish, wrapping the samples in solvent washed aluminum foil, tagging them and placing each sample in a plastic bag. Scales samples were collected for age determination.

The right fillets of the five original bullheads and the left fillets of all other fish were shipped on dry ice to the Brehm Laboratory of Wright State University in Dayton, Ohio. The bullheads were analyzed individually, the two yellow perch were composited into one sample, and the five chain pickerel from each station were composited by station. In all, nine separate samples were analyzed.

Sample analysis was performed using Brehm Laboratory's "Analytic Protocol for Determination of Dibenzo-P-dioxins and Chlorinated Dihenzo-furans in Fish Tissue." High resolution gas chromatography/high resolution mass spectrometry was the analytic tool utilized.

Age determinations from the yellow perch and pickerel were by scale analysis using acetate impressions viewed through a scale projector. Annuli were identified by breaks in the pattern of circuli indicative of a change in growth pattern.

Results

Analysis of the Brehm Laboratory at Wright State University showed that only one fish, a brown bullhead 3+ years old, contained dioxin. This fish was tested twice by Brehm with results of 19 and 25 parts per trillion dioxin (Table A2).

All other fish, including the archived bullheads and more recently captured yellow perch and chain pickerel, had no detectable levels of dioxin. It is noteworthy that the detection limits on all samples exceeded the dioxin concentrations found in the single bullhead.

Conclusions

The second analysis by the Brehm Laboratory confirms the presence of dioxin in a fish from Lake Winthrop, Holliston. The high detection limits in the other samples present a problem since dioxin could possibly be present below these limits. Therefore, it is not possible to conclude that dioxin occurs in a limited number of fish, only in certain species, or only in concentrations below FDA advisory limits.

Table A1. Fish Analyzed for TCDD during Phase II Survey of Lake Winthrop, Holliston, December 6-9, 1983.

Species	Total Length (mm)	Weight (gm)	Age (yrs)	Sample Station
Brown Bullhead[1] (Ictalurus nebulosus)	255	227	3+	1
Brown Bullhead[1]	276	283	4+	1
Brown Bullhead[1]	302	312	4+	1
Yellow Bullhead[1] (Ictalurus natalis)	300	454	4+	1
Brown Bullhead[1]	275	283	3+	1
Yellow Perch (Perca flavescens)	229	113	5+	1
Yellow Perch	178	57	5+	1
Chain Pickerel (Esox niger)	406	425	2+	1
Chain Pickerel	331	227	1+	1
Chain Pickerel	342	425	3+	1
Chain Pickerel	314	198	1+	1
Chain Pickerel	376	340	2+	1
Chain Pickerel	303	142	1+	3
Chain Pickerel	308	170	1+	3
Chain Pickerel	355	340	2+	3
Chain Pickerel	297	142	1+	3
Chain Pickerel	354	340	1+	3
Chain Pickerel	583	1474	3+	4
Chain Pickerel	431	652	3+	4
Chain Pickerel	485	964	5+	4
Chain Pickerel	428	539	4+	4
Chain Pickerel	593	1502	4+	4

[1]Archived bullhead from first sampling.

Table A 2. 2,3,7,8 Tetrachlorodibenzo-p-dioxin Concentrations in Fish Samples from Lake Winthrop, Holliston

Sample Description	Concentration (ppt)[1]
Brown Bullhead (275TL)[2]	19
Method Blank[3]	ND (20)[4]
Brown Bullhead (275TL)	25
Yellow Bullhead (300TL)	ND(27)
Yellow Bullhead (300TL)	182 (Spiked)
Brown Bullhead (302TL)	ND (35)
Brown Bullhead (276TL)	ND (70)
Brown Bullhead (255TL)	ND (58)
Method Blank	ND (40)
Yellow Perch (Sta. 1)	ND (31)
Chain Pickerel (Sta. 1)	ND (29)
Chain Pickerel (Sta. 3)	ND (57)
Chain Pickerel (Sta. 4)	ND (50)

1 - Parts-per-trillion

2 - Total length of the fish for I.D. in Table A1.

3 - A laboratory sample used to check procedures

4 - None detected (lowest detection level in ppt)